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# Hearing treshhold before and after middle ear surgery in chronic suppurative otitis media (CSOM)

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## ABSTRACT

Hearing loss is a common symptom in chronic suppurative otitis media (CSOM), often cause social communication disturbance. Canal wall up tympanoplasty and canal wall down tympanoplasty are surgery procedures for managing this disease that no response to convensional treatment. These surgery procedures should consider to hearing function impact. The aim of this study was to evaluate the difference hearing threshold between before and after middle ear surgery on CSOM patients. It was an historical cohort study conducted from January 2015 to December 2016 involving CSOM patients who underwent canal wall up tympanoplasty surgery and canal wall down tympanoplasty in The Otology Division, Departement of Ear, Nose, Throat, Head and Neck Health, Dr. Sardjito General Hospital, Yogyakarta. The inclusion criteria included basic data, diagnostics, surgery reports, and audiometry results before and 3 months postoperatively, while the exclusion criteria were not complete medical record data. Total of 64 patients with CSOM were involved in this study consisting of 32 patients who underwent canal wall up tympanoplasty and 32 patients who underwent canal wall down tympanoplasty. Significantly different in the increasing of hearing threshold between before and after canal wall up tympanoplasty surgery compared to the canal wall down tympanoplasty was observed ( $p = 0.021$ ). In addition, surgical technique was the main factor affecting postoperative hearing threshold in CSOM patients ( $p < 0.05$ ). In conclusion, the increasing of hearing threshold in CSOM patients underwent canal wall up tympanoplasty surgery is better than those underwent canal wall down tympanoplasty.

## ABSTRAK

Penurunan pendengaran merupakan gejala umum pada penderita otitis media supuratif kronis (OMSK) yang sering menyebabkan gangguan komunikasi sosial. Timpanoplasti dengan metode *canal wall up* dan *canal wall down* merupakan tindakan bedah untuk pengelolaan penyakit ini apabila pengobatan konvensional tidak memberikan respon. Tindakan bedah ini harus mempertimbangkan efek sampingnya pada fungsi pendengaran. Tujuan penelitian ini adalah untuk mengkaji perbedaan antara ambang pendengaran sebelum dan sesudah tindakan bedah telinga tengah pada pasien OMSK. Penelitian kohort

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historik ini dilakukan dari Januari 2015 sampai Desember 2016 melibatkan pasien OMSK yang menjalani timpanoplasti dengan metode *canal wall up* dan *canal wall down* di Divisi Otologi, Departemen Ilmu Kesehatan Telinga Hidung Tenggorok-Kepala dan Leher (THT-KL), RSUP Dr. Sardjito, Yogyakarta. Kriteria inklusi adalah pasien mempunyai kelengkapan data dasar, hasil diagnosis, laporan operasi dan hasil audiometri sebelum dan 3 bulan pasca operasi, sedangkan kriteria eksklusi adalah data rekam medis pasien tidak lengkap. Total sebanyak 64 pasien dengan OMSK yang terdiri dari 32 pasien menjalani timpanoplasti metode *canal wall up* dan 32 pasien metode *canal wall down*. Terdapat perbedaan nyata perbaikan ambang pendengaran sebelum dan setelah timpanoplasti dengan metode *canal wall up* dibandingkan dengan metode *canal wall down* ( $p = 0,021$ ). Selanjutnya terbukti, teknik bedah merupakan factor utama yang berpengaruh terhadap ambang pendengaran pasca operasi pada pasien OMSK ( $p < 0.05$ ). Dapat disimpulkan, peningkatan ambang pendengaran pasien OMSK yang menjalani timpanoplasti metode *canal wall up* lebih baik dibandingkan dengan metode *canal wall down*.

**Keywords** : chronic suppurative otitis media – hearing threshold – middle ear surgery – tympanoplasty - audiometry

## INTRODUCTION

Chronic suppurative otitis media (CSOM) is one of the chronic inflammatory diseases of the middle ear which is characterized by perforation of tympanic membrane and persistent or absent secretions that occur over 3 months. This disease still as problem in Ear, Nose and Throat field.<sup>1</sup> The CSOM can be divided into two types i.e. benign type and danger type (maligna).<sup>2</sup> According to other literature the CSOM can be divided into two types i.e. CSOM with kolesteatoma and CSOM without kolesteatoma. The management of CSOM is different depending on the type.<sup>3,4</sup>

The CSOM is a common worldwide disease especially in developing countries with low socioeconomic status with the prevalence varies from 0.5 to 30%.<sup>5</sup> Prevalence of CSOM surveys worldwide showed the global burden of illness from CSOM involved 65-330 million people with otorrhea, 60% of whom (39-200 million) suffered from significant hearing loss.<sup>2</sup> In Indonesia, the CSOM prevalence ranges from 3.9 up to 5.6%. Data from Hearing and Illumination Health Survey conducted in seven provinces from 1994 to 1996 showed

that the most common cause of middle ear morbidity was benign CSOM (3%).<sup>6</sup> According to the patient's medical records in Departement of Otorhinolaryngology, Head and Neck Surgery, Dr. Sardjito General Hospital Yogyakarta in 1998-1999, 40 patients with CSOM was recorded and 25 (62.5%) of them underwent mastoidectomy surgery.<sup>7</sup>

Chronic suppurative otitis media causes damage to some or all of the tympanic membrane and affects hearing loss with a maximum reduction of 40 dB. Tympanic membrane perforation with damage auditory ossicles may affect the hearing loss of conduction-type hearing loss by 60 to 70 dB.<sup>5,8</sup> The type of deafness caused by CSOM in the form of conductive deafness and deafness of the mixture with the degree of deafness depends on the involvement of the hearing bones.<sup>9</sup> Chronic suppurative otitis media can be managed with medical treatment and surgery. Tympanoplasty is a technique of middle ear surgery with the goal of eradication of pathological tissue and infection in the middle ear and reconstruct hearing mechanisms with or without graft and reconstruction of the

hearing bones, this surgical technique can be combined with canal wall up mastoidectomy or canal wall down with the aim of eradication of disease in the mastoid region and middle ear.<sup>1</sup>

Examination of pure tone audiometry is a still relevant assessment of hearing status. Audiometry can be used to assess the presence or absence of post-surgical hearing repair in the middle ear by measuring both air delivery and bone conduction at frequencies 500, 1000, 2000, 4000, 8000 Hz, for the calculation of mean hearing threshold values can be measured at frequencies 500, 1000, 2000 Hz because these frequencies represent daily conversations.<sup>1,8</sup> The aim of this study was to evaluate the difference hearing threshold before and after middle ear surgery between canal wall up tympanoplasty and canal wall down tympanoplasty procedures in patients CSOM.

## **MATERIALS AND METHODS**

### **Subjects**

This was an observational retrospective cohort study to evaluate the difference hearing threshold of CSOM patients between before and after middle ear surgery using canal wall up tympanoplasty and canal wall down tympanoplasty technique. The study was conducted over a period of January 2015 until December 2016 in the Otology Division, Departement of Otorhinolaryngology, Dr. Sardjito General Hospital Yogyakarta on CSOM patients who meet the inclusion and exclusion criteria. The inclusion criterion included basic data, diagnostics, surgery reports, and audiometry results before and 3 months postoperatively, while the exclusion criteria were not complete medical record data.

### **Protocol of study**

All patients who presented signs and symptoms suggesting CSOM based on medical record data and underwent middle ear surgery both with canal wall up and canal wall down tympanoplasty methods by the same surgeon were identified. Thereafter, the patients were grouped into two groups i.e. group of patients who underwent canal wall up tympanoplasty and group of patients who underwent canal wall down tympanoplasty. The audiometry was conducted following standard protocol before and 3 months after surgery. For calculation of average hearing loss four frequencies were selected i.e. 500, 1000, 2000 and 4000 Hz and assessed by air-bone conduction range (ABG). Protocol of this study has been approved by the Health Research Ethics Committee of the Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta (Ref: KE/FK/0196/EC/2017).

### **Statistical analysis**

The differences of ABG at the frequency of 500, 1000, 2000 and 4000 Hz in each middle ear surgery method were analyzed using independent t-test. Furthermore, the difference of ABG between before and after surgery was analyzed using paired t-test. A p value < 0.05 was considered to be significantly different.

## **RESULTS**

Sixty four CSOM patients consisting 32 patients undergoing a canal up wall tympanoplasty and 32 patients undergoing a canal wall down tympanoplasty procedures were included in this study. The mean age of patients undergoing the canal wall up tympanoplasty was  $36.78 \pm 12.21$  years with the youngest aged 18 years and the oldest aged

60 years, whereas the mean age of patients undergoing canal wall down tympanoplasty was  $32.88 \pm 14.91$  years with the youngest aged 8 years and the oldest aged 56 years (TABLE 1). No significantly different was observed in the mean age of the both groups ( $p=0.246$ ). Distribution of sex in the group of

canal wall up tympanoplasty were 16 (51.61%) male patients and 16 (48.48%) female patients, whereas in the group of canal wall down tympanoplasty were 15 (48.39%) male patients and 17 (51.52%) female patients. No significantly different was also observed in the sex distribution of the both groups ( $p=0.210$ ).

**TABLE 1. The basic characteristics of patients**

Variable	Canal wall up tympanoplasty	Canal wall down tympanoplasty	p
Age (mean $\pm$ SD years)	36.78 $\pm$ 12.21	32.88 $\pm$ 14.91	0.246 <sup>a</sup>
Sex [n (%)]			
Male	16 (51.61)	15 (48.39)	0.210 <sup>b</sup>
Female	16 (48.48)	17 (51.52)	
AC (mean $\pm$ SD dB)			
AC 500 Hz	46.25 $\pm$ 13.01	64.22 $\pm$ 13.14	0.001 <sup>a</sup>
AC 1000 Hz	46.88 $\pm$ 1.55	66.72 $\pm$ 14.73	0.001 <sup>a</sup>
AC 2000 Hz	46.88 $\pm$ 11.13	66.41 $\pm$ 13.33	0.001 <sup>a</sup>
AC 4000 Hz	42.81 $\pm$ 14.59	63.13 $\pm$ 14.91	0.001 <sup>a</sup>
BC (mean $\pm$ SD dB)			
BC 500 Hz	13.75 $\pm$ 10.63	25.16 $\pm$ 12.92	0.001 <sup>a</sup>
BC 1000 Hz	12.19 $\pm$ 7.61	27.19 $\pm$ 11.77	0.001 <sup>a</sup>
BC 2000 Hz	18.44 $\pm$ 8.47	30.00 $\pm$ 14.59	0.001 <sup>a</sup>
BC 4000 Hz	15.47 $\pm$ 11.59	30.31 $\pm$ 14.69	0.001 <sup>a</sup>
ABG (mean $\pm$ SD dB)			
ABG 500 Hz	32.5 $\pm$ 12.38	39.06 $\pm$ 14.67	0.058 <sup>a</sup>
ABG 1000 Hz	34.69 $\pm$ 13.67	39.22 $\pm$ 18.87	0.209 <sup>a</sup>
ABG 2000 Hz	28.43 $\pm$ 10.88	36.41 $\pm$ 10.94	0.005 <sup>a</sup>
ABG 4000 Hz	27.34 $\pm$ 12.51	32.81 $\pm$ 11.21	0.070 <sup>a</sup>

Note : SD: standard deviation; AC: air conduction; BC: bone conduction; ABG: air bone gap; <sup>a</sup>:independent t-test; <sup>b</sup>: chi-square;

Table 2 show the difference between air conduction (AC) and bone conduction (BC) both group of surgical methods. For the difference of air surge increase based on surgery on each frequency 500 Hz, 1000

Hz, 2000 Hz and 4000 Hz in both groups not statistically significant difference with  $p > 0.05$  as in table 3, while table 4 show the air-bone gap between before and after surgery.

**TABLE 2. Differences AC (mean  $\pm$  SD dB) before and after surgery at each audiometric frequency**

Frequency	Method	Before surgery	After surgery	p
500Hz	Canal wall up tympanoplasty	46.25 $\pm$ 13.01	40.78 $\pm$ 12.12	0.006
	Canal wall down tympanoplasty	64.22 $\pm$ 13.14	59.06 $\pm$ 16.19	0.001
1000Hz	Canal wall up tympanoplasty	46.88 $\pm$ 13.55	40.47 $\pm$ 10.58	0.001
	Canal wall down tympanoplasty	66.72 $\pm$ 14.73	63.28 $\pm$ 17.63	0.001
2000Hz	Canal wall up tympanoplasty	46.88 $\pm$ 11.13	39.84 $\pm$ 8.37	0.003
	Canal wall down tympanoplasty	66.41 $\pm$ 13.33	62.03 $\pm$ 16.16	0.001
4000Hz	Canal wall up tympanoplasty	42.81 $\pm$ 14.59	41.41 $\pm$ 13.27	0.515
	Canal wall down tympanoplasty	63.13 $\pm$ 14.91	60.00 $\pm$ 17.60	0.001

Note : AC: air conduction

**TABLE 3. Differences in the increase in AC (mean  $\pm$  SD dB) based on the type of surgical method at each audiometric frequency**

Frequency	Canal wall up tympanoplasty	Canal wall down tympanoplasty	p
500 Hz	5.47 $\pm$ 10.5	5.16 $\pm$ 10.36	0.905
1000 Hz	6.41 $\pm$ 9.86	3.44 $\pm$ 9.95	0.235
2000 Hz	7.03 $\pm$ 12.17	4.38 $\pm$ 8.4	0.314
4000 Hz	1.4 $\pm$ 12.06	3.13 $\pm$ 8.4	0.511

Note : AC: air conduction

**TABLE 4. Differences ABG (mean  $\pm$  SD dB) before and after surgery at each audiometric frequency**

Frequency	Method	Before surgery	After surgery	p
500Hz	Canal wall up tympanoplasty	32.50 $\pm$ 12.38	27.19 $\pm$ 11.07	0.039
	Canal wall down tympanoplasty	39.06 $\pm$ 14.67	36.09 $\pm$ 14.01	0.142
1000Hz	Canal wall up tympanoplasty	34.69 $\pm$ 13.67	29.53 $\pm$ 10.73	0.039
	Canal wall down tympanoplasty	39.22 $\pm$ 14.87	37.81 $\pm$ 14.86	0.397
2000Hz	Canal wall up tympanoplasty	28.43 $\pm$ 10.88	21.72 $\pm$ 9.97	0.004
	Canal wall down tympanoplasty	36.41 $\pm$ 10.94	33.75 $\pm$ 11.43	0.074
4000Hz	Canal wall up tympanoplasty	27.34 $\pm$ 12.51	23.59 $\pm$ 10.49	0.021
	Canal wall down tympanoplasty	32.81 $\pm$ 11.21	30.31 $\pm$ 12.70	0.065

Note : ABG: air bone gap

## DISCUSSION

No significantly different was observed in the mean of patients age and sex distribution of the both groups. The results of this mean age and sex distribution were consistent with

the results reported by Shyvakumar *et al.*<sup>10</sup> which showed the patients mean was 30.14  $\pm$  0.98 years consisting 24 (48%) male and 26 (52%) among 50 CSOM patients involved in their study. It was indicated that the CSOM



became a major problem in the productive age in the male and female patients.

The AC and BC hearing thresholds of CSOM patients undergoing canal wall up tympanoplasty at each audiometric frequency (TABLE 2 and 4) were significantly different compared to those who undergo canal wall down tympanoplasty ( $p=0.001$ ). These suggest a more severe hearing loss in patients who underwent canal wall up tympanoplasty than in canal wall down tympanoplasty group. The CSOM patients have pathological abnormalities with the extension of pathological tissue and cholesteatoma reaching to mesotympany and hypotympanic areas so that there is damage to the circuit of hearing bone and also happened fixation of stapes foot which impact on decreasing threshold reach 60 dB or more.<sup>2,11</sup> Albera *et al.*<sup>12</sup> reported that 82% of patients with malignant/ cholesteatoma CSOM had impaired or impaired hearing bone chain. More than 78% of damage occurred in incus auditory bone and more than 45% of damage occurred in more than one hearing bone. This results in heavier conductive deafness when compared with CSOM patients in the absence of cholesteatoma in addition to the presence of cholesteatoma tissue in a nice round window region will result in impedance and phase disturbance in the oval and transparent lobes resulting in noise conduction disturbance in the cochlea.<sup>11,13</sup>

Other factors that may result in decreased bone conduction in patients with CSOM are influenced by: 1) sealed or obliterated round window by middle ear granulation tissue that affects the loss of phase difference between round window and oval window, 2) stiffness of hearing bone as a result of granulation tissue and cholesteatomas that envelop the hearing bones, 3) perforation and discontinuities of the hearing bone.<sup>4</sup>

The difference between the air-bone conductivity range in each group of both canal wall up and canal wall down tympanoplasty is statistically significant, especially at 2000 Hz ( $p=0.005$ ). The diagnosis and management of each group sample has been adjusted for clinical indications and considerations for the selection of surgical procedures. Patients with a diagnosis of chronic active suppurative otitis media of unsigned benign/ unsafe type performed canal wall up tympanoplasty procedures, while patients with chronic malignant suppurative otitis media were performed by canal wall down tympanoplasty surgery. The selection of these two surgical techniques is based on the extension of the pathologic/ cholesteatoma tissue, access to reach the tympanic cavity area, the threshold value and the presence or absence of both intratemporal and intracranial complications.<sup>11</sup>

The significant differences between AC hearing thresholds on canal wall up tympanoplasty and canal wall down at frequencies 500 and 1000 and 2000 Hz was observed ( $p<0.05$ ). However, there is significant differences at frequencies 4000 Hz ( $p=0.515$ ). This suggests that the surgery performed on the CSOM patients accompanied by a good middle ear reconstruction with canal wall up tympanoplasty techniques and canal wall down tympanoplasty can improve the conduction system in the auditory process. This result does not differ greatly from the previous study research in which the pre-operation airbone threshold at frequencies 500, 1000, 2000 and 3000 Hz at  $51 \pm 13$  dB and after surgery to  $40 \pm 11$  dB.<sup>14</sup>

Significant differences in outcome of the air-bone conduction range, especially in the canal wall up tympanoplasty group before and after surgery at all frequencies (TABLE 4) were observed ( $p<0.05$ ). However, no significant differences of the air-bone conduction range

in canal wall down tympanoplasty group were observed as shown in TABLE 4 ( $p>0.05$ ). This result are similar to the previous study which reported that no significantly differences in air-bone conduction in ABG between canal wall up tympanoplasty and canal wall down tympanoplasty after surgery with a value of 10.9 dB in canal wall uptank and 13.5 dB on the wall tympanoplasty collapsed.<sup>15</sup>

## CONCLUSION

In conclusion, canal wall up tympanoplasty in CSOM patients is better to improve hearing threshold compared to canal wall down tympanoplasty.

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